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Evaluation of Methods Used to Desorb the Constituents Adsorbed on the Charcoal Contained in Automotive Evaporative Canisters. Part 1

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This study evaluates current extraction methods for analyzing charcoal canisters which are used to control evaporative emissions in automobiles. The initial phase of the study investigated various extraction procedures and solvents, including carbon disulfide, methanol, cyclohexane, methylene chloride, and a mixture containing carbon disulfide and 12% acetone. These solvents were used in the soxhlet extraction of evaporative hydrocarbons adsorbed on the charcoal of the canister. In another procedure the charcoal was subjected to ultrasonication with carbon disulfide as the extraction solvent. The various sample extracts were analyzed for detailed hydrocarbon by gas chromatography and results of the procedures were compared. Identification of the major components quantitated by the gas chromatograph was done by either injecting the individual pure hydrocarbons into the chromatograph and then comparing the relative retention times of the unknowns and standards, or by GC/MS using identical columns and temperature programming parameters. The percent of the extracted material accounted for by the analysis of the sample extracts was greater than what had been found in the previous canister study. The difference between the results of the soxhlet extractions in this study and those in the previous study was that there had been a significant increase in the quantity of aromatics measured. The differences in the procedures for sample introduction into the GC was determined to result in fewer measureable hydrocarbons in the prior study.

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ABSTRACT

This study evaluates current extraction methods for analyzing charcoal canisters which are used to control evaporative emissions in automobiles. The initial phase of the study investigated various extraction procedures and solvents, including carbon disulfide (CS_2), methanol (CH_3OH), cyclohexane (C_6H_{12}), methylene chloride (CH_2Cl_2), and a mixture containing CS_2 + 12% acetone. These solvents were used in the soxhlet extraction of evaporative hydrocarbons (HCs) adsorbed on the charcoal of the canister. In another procedure the charcoal was subjected to ultrasonication with CS_2 as the extraction solvent. The various sample extracts were analyzed for detailed HCs composition by gas chromatography (GC) and results of the analytical procedures were compared. Identification of the major HCs components quantitated by the GC was determined by either injecting the individual pure HCs into the GC and then comparing the relative retention times (RRT) of the unknowns and standards, or by gas chromatography/mass spectrometry (GC/MS) using identical columns and temperature programming parameters.

A total of nine charcoal canisters were analyzed for this comparative study. Of these nine, five were submitted for analysis by the Manufacturers Operation Division (MOD) of EPA and had been analyzed in a previous study. Two canisters were taken from an in-house evaporative emissions project that had controlled the loading and purging of the canisters with gasoline vapors of known composition. The remaining two canisters were unused canisters and were therefore designated as blanks since they had never been used to collect evaporative emissions.

The total quantity of material soxhlet extracted from the charcoal samples was essentially the same for each of the various solvents used, except

for methanol. When methanol was used as the extracting solvent, less material was extracted. When the samples were ultrasonicated in CS_2 more material was extracted. However, for the HC fraction of the extract, the results of the detailed HC analysis of the ultrasonicated method indicated that the quantity (weight percent) of the individual HC's measured and, therefore, the total sum of the HCs were the same as was measured from the soxhlet method.

The percent of the extracted material accounted for by the GC/FID detailed HC analysis of the sample extracts was greater than what had been found in the previous canister study. The difference between the results of the CS_2 soxhlet extractions performed in this study and the previous CS_2 extractions was that there had been a significant increase in the quantity of aromatics measured. The differences in the procedures for sample introduction into the GC analytical systems was determined to result in less measurable HCs in the previous canister study.

The second phase of this study will investigate solventless extraction techniques involving high pressure CO_2 soxhlet extractions, vacuum transfer extractions, microwave and thermal desorption, and supercritical fluid extraction-supercritical fluid chromatography. A comparison of the solvent and solventless extraction procedures will determine their accuracy. If the solventless method proves accurate and viable, it will eliminate the current solvent method peak interferences, as well as reducing the potential for contamination of the samples with solvent impurities such as benzene in CS_2. The second phase of this study should be completed and the results reported by June 1989.

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SECTION 1

INTRODUCTION

Evaporative HC emissions from gasoline powered vehicles are controlled by the use of charcoal canisters. The Sealed Housing for Evaporative Determinations (SHED) test is used to determine canister effectiveness in controlling evaporative emissions during simulated vehicle operation(1). The determination of the nature and quantity of the material adsorbed and retained on the charcoal contained in these canisters will aid in the assessment of canister performance There is concern that, in the analysis of the canisters, using the present extraction methods may alter the quantity and quality of hydrocarbons or other materials desorbed from the canister's carbon. It is also unknown as to which of the current methods of desorbing the organic hydrocarbon constituents from the carbon is the most effective. Many studies (2-7) which involve the collection and analysis of organic pollutants in ambient air and industrial atmospheres initially used activated carbon as the collection media. The National Institute for Occupational Safety and Health (NIOSH) has specified a charcoal adsorption tube technique for measuring concentrations of more than 100 individual chemicals detected in air (8). This method is applicable to gases, vapors, and aerosols that can be collected efficiently by charcoal adsorption and then removed efficiently by an elution agent such as carbon disulfide.

Recovery of trapped vapors on charcoal has also been accomplished using thermal, >700°C, (6) and vacuum normal desorption (9) which allow for the direct introduction of the total sample into an analytical system in the absence of a solvent as a carrier. Unfortunately these methods are subject to artifactual processes such as pyrolysis, polymerization, or incomplete

recovery. Steam desorption (10) and solvent extraction (2,11,12,13) of the sorbent alleviate the above mentioned problems. In the analysis of ambient air samples, however, volatile pollutants cannot be quantitatively concentrated, and since gas chromatographic analysis is limited to small aliquots of liquid samples, only a fraction of the sample can be examined.

There have also been a number of questions concerning the variability in recovery (desorption efficiency) of the materials adsorbed on the charcoal (8,11,13,14,15). Desorption efficiencies using the charcoal tube technique for a number of compounds using various solvents are included in literature available from equipment suppliers (16,17). The majority of ambient air studies and analyses have been performed by extracting very small quantities (nanograms) of material adsorbed on usually 400 milligrams or less of charcoal using 2mL or less of solvent. In contrast, this study involved the measurement of the contents of charcoal canisters which usually contained milligrams of material adsorbed on approximately 150 grams of charcoal.

This report describes the first phase of a two phase study concerning the determination of the most effective, repeatable and accurate procedure of desorbing and analyzing the organic constituents collected on charcoal contained in automotive evaporative canisters.

This first phase involved the use of various solvents or a combination of solvents to extract the charcoal in a soxhlet extraction apparatus. The solvent extraction procedure usually provides an indication of the maximum amount of adsorbed material that can be extracted from the charcoal. A GC detailed HCs analysis of the sample extracts was then performed in order to measure the amount of and identify the individual HCs adsorbed on the charcoal. The sum of the measured HCs provided information concerning the percent of the total extractable material which could be identified. Ultrasonication

of the charcoal with CS_2 as the extracting solvent and subsequent GC analysis of the extracts was also performed.

The second phase of this study will investigate solventless extractions of the charcoal including, a vacuum transfer method, high pressure CO_2 soxhlet extraction, microwave and thermal desorption and supercritical fluid extraction-supercritical fluid chromatography.

A comparison of the solvent and solventless extraction procedures will determine their accuracy. If any of the solventless methods proves accurate and viable, it will be recommended as the preferred extraction procedure. Solventless extractions eliminate solvent peak interferences during the GC detailed HC analysis of the sample extracts as well as eliminate the potential of solvent impurities contaminating the samples.

SECTION 2

CONCLUSIONS

The total quantity (by Wt. %) of material soxhlet extracted from the charcoal samples was essentially the same for the various solvents tested, except for methanol.

Methanol was determined not to be a viable extracting solvent especially if C_7 and/or C_8 branched paraffins were present in the sample, since these compounds are not completely soluble in methanol.

When the charcoal samples were ultrasonicated in CS_2, more extractable material was obtained. If a comparison is made of the results of the GC/FID analysis of the samples ultrasonicated in CS_2 and the various soxhlet extractions of the same samples these results indicate that the measured amounts (percentages) of most of the individual HC's were essentially the same. Sonication of the charcoal with CS_2, therefore, appears to be quite useful for charcoal canister evaluation since it requires less time effort, 1 hour vs. 3 hours, to perform the extraction. The ultrasonic procedure also alleviates some of the potential hazards associated with CS_2 soxhlet extractions such as using hot plates with flammable CS_2 and having to use expensive and breakable glassware to perform the extractions.

Extractions performed on two charcoal canisters that have been loaded and purged with gasoline vapors of known composition for a short period of time indicate that the soxhlet or ultrasonic extraction procedures are capable of accounting for 84 to 87 percent of the material adsorbed. The solvent peak interference with the measurement of the C_4 and C_5 HCs, however, prevents complete characterization of these extracts.

The charcoal canisters that had not been previously exposed to gasoline vapors or evaporative emissions (blanks) contained 14 to 16% moisture and >1.0% HCs.

Three hours is the maximum time to allow for complete extraction of the material adsorbed on the charcoal when performing soxhlet extractions. Ultrasonic extraction of the charcoal samples with CS_2 requires one hour for complete desorption.

SECTION 3

RECOMMENDATIONS

The results from the first phase of this study indicate that there does not appear to be any one solvent that extracts more material from the charcoal samples by soxhlet extraction. The amount of material extracted was essentially the same for the various solvents used, except for methanol. Soxhlet extraction of the charcoal using the solvent/s CS_2 or CS_2/12% acetone is preferred rather than using the other solvents tested because the CS_2 solvent peak only interferes with the measurement of the C_5 HCs. The solvent peak of cyclohexane or methylene chloride interferes with the measurement of both the C_6 and C_7 HCs which were present in relatively high concentrations in these canister samples. If, however, the charcoal sample contains appreciable quantities of relatively low molecular weight HC's, then the CS_2 interference limits the complete characterization of the extract and another extraction procedure, preferably solventless, should be performed.

The extracts obtained from the ultrasonication of the samples with CS_2 should be investigated further, since more material was desorbed from the charcoal as compared to the quantity desorbed by soxhlet extraction. This investigation should involve the use of polar columns and GC/MS to determine if any polar and/or oxygenated compounds are also being extracted, but have not been detected by the GC/FID detailed HC method.

SECTION 4

PROCEDURES AND INSTRUMENTATION

Handling and Storage of Charcoal Canisters -- A total of nine canister samples were analyzed for this study. Of these nine, five had been prepared and analyzed previously. These samples were selected because of the differences in their moisture content and in the amount of material that had been extracted from them. The charcoal samples were stored in amber glass bottles in a -20°C freezer. Two of the canisters were taken from an in-house evaporative emission project (18,19). The loading and purging of the canisters had been performed under controlled conditions. One canister was loaded with gasoline vapors from a base stock gasoline and was labeled gasoline-base. The other canister was loaded with gasoline vapor containing 10% oxinol (5% methanol + 5% t-butyl alcohol). This canister was labeled gasoline-blend. When the in-house canister project had been completed, the two canisters were then stored in sealed bags inside a refrigerator for several weeks before they were required for this project. The canisters were opened and the charcoal riffled using the same procedure as had been described previously (21). They were then stored in a -20°C freezer until required for analysis. The two remaining charcoal canisters had never been used on any vehicle. These canisters were contained in cardboard cartons and were exposed to the atmosphere for an undetermined amount of time. At the beginning of this project these two samples were prepared for analysis at the same time as the in-house tested canisters.

REAGENTS AND APPARATUS

Reagent grade solvents were used for all the soxhlet and ultrasonic

extraction procedures as well as for the preparation of standards. The pure HC standards were obtained from Polyscience Corp. Niles, IL.

The soxhlet apparatus consisted of a multi-unit extraction heater with individual heating controllers (Fisher Scientific), 125 mL flat bottom short neck flasks with 24/40 joints and the soxhlet extraction tube (39 mm i.d.) with a 34/45 joint connected to a condenser. Whatman pure cellulose thimbles (80 mm length x 22 mm diameter) were used to contain the charcoal for extraction. Glass thimbles (85 mm length x 25 mm diameter) were used to contain the charcoal when methylene chloride was used as the extracting solvent.

SOXHLET PROCEDURE

The soxhlet extraction procedure was performed as described previously (21) for all the extracting solvents. Either 5 grams or 2 grams (±0.01 grams) of the charcoal samples were extracted in order to have enough sample available for the second phase of this study and to reduce the potential for the incomplete extraction of the large, 10 gram, mass of sample. The water in the condensers was maintained at 15°C by the use of a refrigerated recirculating water bath (Model 2095, Forma Scientific) in order to reduce the loss of the volatile components of the extract from the extraction apparatus.

ULTRASONIC PROCEDURE

Ultrasonic extractions were performed by adding 80 mL of the extraction solvent to a 125 mL erlenmeyer flask that had been conditioned (let stand in a desiccator for 30 minutes) prior to the weighing out of the sample.

Usually 2.0 grams (±0.01 gram) of the charcoal sample was weighed out for extraction. The flask was stoppered with a teflon stopper and the charcoal sonicated for one hour. The water in the ultrasonic bath was allowed to remain at ambient temperature. After the sonication had been completed the charcoal was then separated from the extracting solvent by ouring the mixture through a preweighed and conditioned cellulose thimble into a 100 mL volumetric flask. The thimble was supported in a large glass funnel in order to insure quantitative transfer of the charcoal and the extract. The cellulose thimble containing the extracted charcoal was dried and the weight loss measured using the same procedure as performed after completion of the soxhlet extractions.

GAS CHROMATOGRAPHIC EQUIPMENT AND PROCEDURES

A Hewlett Packard Model 5880 GC equipped with a flame ionization detector was used to analyze the samples. Sample introduction into the GC was accomplished by directly injecting an aliquot of the sample into the GC system using a 10 uL syringe.

Another GC, a Perkin Elmer Model 3920 equipped with a flame ionization detector, was also used to analyze some of the sample extracts and the results compared. This instrument had been used routinely for detailed HC's analyses of gasoline samples and automobile exhaust. The Perkin Elmer GC was not equipped with a liquid injection system. An aliquot of the sample was vaporized into a tedlar bag and then introduced into the GC system using a 10 mL sample loop. This method of sample introduction had been used in the previous canister study and the procedure already described (20,21).

The same capillary column, a 60 m x 0.32 mm i.d. DB-1 with a 1.0 u film

thickness, had been used by the two GC systems to perform the detailed HC analyses of the extracts.

The operating parameters were as follows:

	Hewlett Packard	Perkin Elmer
Injection Port Temp.	150°C	Sample loop at ambient
Detector Temp.	150°C	250°C
Programming Parameters:		
Initial Oven Temp.	30°C	-95°C
Initial Time	5 min	1 min then ramp to -45°C
Temp. Program Rate	3°C/min	8°C/min
Final Oven Temp.	150°C	235°C
Carrier Gas	Helium	Helium
Flow rate	2 mL/min	1.5 mL/min

RESPONSE FACTOR DETERMINATION

Hewlett Packard GC -- Response factors for the quantitative determination of the individual HCs were obtained by analyzing solutions containing measured amounts of the pure HCs. The solutions were prepared to contain a final concentration of 0.05 Wt. %, 0.1 Wt. % and 0.5 Wt. % of each compound in either CS_2 or CH_3OH. A linear response was obtained for all the compounds at the concentrations measured. These standard solutions were then analyzed at the same time as the sample extracts in order to maintain quality assurance of the instrumental response.

PERKIN ELMER GC

The calibration of the Perkin Elmer GC/FID was accomplished using a propane standard traceable to the National Bureau of Standards. Response factors were then obtained by the preparation of a mixture of HC's and comparing the calculated concentrations vs the calibrated FID. This mixture of HCs, which was contained in a pressurized cylinder, was then analyzed daily for quality assurance of instrumental response.

MOISTURE DETERMINATION

Moisture analyses were performed using ASTM Method D 2867 (test method for moisture in activated carbon).

SECTION 5

RESULTS AND DISCUSSION

The results of the moisture determinations of the nine canister samples analyzed are presented in Table 1. The samples were analyzed in duplicate and the averages of the duplicates is presented. The reproducibility of the duplicates was ±5%. Included in Table 1 are the results obtained from the moisture determination of the five canister samples analyzed previously. These results indicate that the moisture content of the samples had not changed after the charcoal had been stored in a -20°C freezer for one to two years.

The total % alcohols (in Wt. % on carbon) that had been determined in the previous canister study are also listed in Table 1. An attempt will be made to determine the quantity of methanol, ethanol, and t-butyl alcohol in all of the charcoal samples in the second phase of this study using the procedure described previously (21) in order to provide a more complete characterization of the adsorbed material.

A comparison of the total amount of material extracted from the charcoal samples with the various solvents tested is presented in Table 2. The total amount of material extracted is expressed in terms of weight percent (Wt. %) using the equation

$$\frac{\text{(weight loss of (dried) charcoal)}}{\text{(weight of sample)}} \times 100 = \text{Total Wt. \% extracted}$$

The samples were analyzed in duplicate and the average of each duplicate is presented in this table. The reproducibility of the duplicates was within 10%. Only sample A151/0420 was not analyzed in duplicate due to sample container

breakage and, therefore the necessity to conserve this sample for future study.

The quantity of material extracted from the charcoal samples using the solvents tested was essentially the same except for methanol. Ultrasonication of the charcoal samples with CS_2 usually resulted in the extraction of 5-10% more material as compared to the soxhlet extractions. When sample A152/0237 wa ultrasonicated in CS_2 20% more material was extracted as compared to the amount of material obtained from the soxhlet extraction procedure. The detailed HC's GC/FID analysis of this ultrasonicated sample, however, indicated that the same quantity of HC's were present in this extract as compared to the soxhlet extracts. The extract obtained from the ultrasonication of sample A152/0237 will be investigated further using polar columns for GC and GC/MS analysis of this sample in order to determine if it contains oxygenates or other organic compounds.

The results in Table 2 also indicate that the same amount of material had been extracted from the five charcoal samples as had been determined previously by soxhlet extraction with CS_2. This indicates that charcoal samples can be stored in a -20°C freezer for as long as two years and not lose any CS_2 extractable material.

The material extracted from the unused canisters (blanks) was essentially the moisture content on the carbon since one step in the procedure used to determine the weight loss of the extracted charcoal includes the drying of the extracted samples in a 150°C vacuum oven.

A comparison of the results obtained from the GC/FID detailed HC analysis of extracts for the various solvents listed is present in Table 3. The total wt. % as determined by the GC/FID method represents the sum of the Wt. %s of the individual HCs measured for each extracted sample. A detailed description

of the composition of the HCs in each of these samples relative to their class, such as n-paraffin, aromatic etc., and their carbon number vs. class is presented in Tables 3(A-G) and 4(A-G). Only the CS_2 ,CS_2/12% acetone, and methanol extracts were analyzed by GC for their HC content because the

cyclohexane and methylene chloride solvent peaks interfere with the measurement of the C_6 and C_7 HCs which are usually present in high concentrations in the canister charcoal. The CS_2 and CH_3OH solvent peaks prevents measurement of the C_5 HCs which are not usually present in "aged" canister samples.

The data in Table 3 indicates that the quantity of HCs extracted by the CS_2 ,CS_2 +12% acetone soxhlet extraction procedure and ultrasonicating the sample with CS_2 was essentially the same. The addition of acetone (12% by volume) to the CS_2 extraction solution does not appear to extract any more HCs than the extraction with CS_2 alone. Ultrasonication of the samples in CS_2 resulted in the extraction of more material but did not extract more HCs.

The results in table 3, which include a comparison of the CS_2 soxhlet extraction of the five canister samples previously analyzed, indicate that more HC's were measured in the present extracts than before. The only significant difference between the results obtained in this study and the previous canister study was in the amount of aromatics measured in these samples (see tables 3A-E).Further investigation of HC's composition of these extracts, as defined in tables 4A-E, indicates that the differences in the quantity of the aromatics measured, for each carbon number, varied from sample to sample. It should be noted that most of the unknowns could be classified as aromatics since approximated 90% of these compounds were observed to elute in the region of the chromatograms that contain mainly alkyl aromatics. Standards were not available for the GC RRT identification of these compounds and the GC/MS total ion chromatogram obtained from the analysis of these samples did not have sufficient resolution in this region to be clearly comparable to the chromatograms obtained from the GC/FID.

The difference in the total HC's measured for the present and previous CS_2 soxhlet extraction of sample A151/0320x has already been suggested (20). The method of GC/FID extract analysis in the previous study required the vaporization of an aliquot of the sample extract into a tedlar bag before it could be analyzed by GC. The sample must have been burned when the vaporization apparatus temperature was set at 210°C instead of 190°C and this resulted in less measurable HCs.

The total amount of HCs determined in the extracts obtained from the use of methanol as extraction solvent was significantly less than the HCs measured in the CS_2 extracts. The difference between the HC's concentrations measured from the methanol extracts and the HC's concentrations measured from the CS_2 extracts is clearly evident from the data in tables 3(A-G) and tables 4(A-G). The data in tables 3(A-G) indicates that less of the branched paraffins had been extracted when the samples were soxhlet extracted with methanol as compared to the extractions with CS_2 . The data in tables 4(A-G) further indicates that the C_7 and C_8 branched paraffins have not been completely extracted from the charcoal by the methanol solvent as compared to CS_2 .

Included in tables 3A-E are the results when several of the soxhlet extracted samples were analyzed using another GC utilizing a completely different sample introduction system as a comparison of GC/FID detailed HC analysis procedures. The results for four of the five samples analyzed indicate very close agreement between the GC systems.

A comparison of the percent of extracted material accounted for by the GC/FID with the solvents and procedures listed is presented in Table 5. The percent of the extracted material accounted for by the GC/FID method is determined by the following equation

$$\frac{(\text{weight \% HC's determined by GC/FID + \% moisture})}{(\text{total quantity, in Wt. \%, material extracted})} \times 100$$

The results in Table 5 indicate that the percent of the material in the extract that could be accounted for from the detailed HC's analysis of these extracts varied from sample to sample. It was possible, however, to account for from 84 to 87% of the material soxhlet extracted from the two charcoal samples taken from an in-house study. These canister samples were expected to contain mainly gasoline HCs as they were not loaded and purged for a long period of time as compared to automotive evaporative canisters.

Three of the samples were soxhlet extracted for six hours using methanol as the extracting solvent in order to determine if any more material would be extracted as compared to the three hour extraction. The results obtained indicated that the quantity of material extracted was less for the six hour extraction than for the three hour extraction. This material loss was especially noticable in the extraction of the in-house canister samples since these canisters contained higher concentrations of more volatile HCs and the longer extraction time (6 hours) allowed this volatile material to escape from the extraction apparatus.

Less material was extracted from the charcoal when two of the samples were ultrasonicated in CS_2 for 30 minutes as compared to ultrasonicating the samples for 60 minutes. Two other samples that were ultrasonicated for 60 minutes were resonicated with CS_2 for another 60 minutes. No more extractable material was measure after the samples were resonicated.

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19. P. Gabele and N. Perry " Effect of purge air humidity on automotive evaporative control performance," Presented at the 81st Annual Meeting of APCA June 1988.

20. D. Dropkin Final Report to C. Dean (MOD) July 15, 1986.

21. R. Zweidinger Report to T. Tesorieio (MOD) Dec. 14, 1984.

TABLE I

% MOISTURE AND % ALCOHOLS

SAMPLE NUMBER	DATE REMOVED	% MOIS.(1)	% MOIS.(2)	% ALCOHOLS(3)
A152/0599	6/3/85	<1.0	<1.0	ND
A151/0420	4/3/86	5.0	4.8	0.09
A152/0237	8/22/84	<0.2	0.0	0.03
A151/0320X	3/2/86	16.4	17.4	0.27
A152/0282	3/24/86	4.8	4.7	0.51
GASOLINE(BASE)	NA	ND	4.5	ND
GASOLINE(BLEND)	NA	ND	5.6	ND
UNUSED CANISTER #1	NA	ND	16.3	ND
UNUSED CANISTER #2	NA	ND	14.1	ND

1- % MOIS. DETERMINED IN PREVIOUS CANISTER STUDIES

2- % MOIS. DETERMINED DURING PRESENT CANISTER STUDY

3- % TOTAL ALCOHOLS DETERMINED IN PREVIOUS CANISTER STUDIES

NA - NOT APPLICABLE

ND - NOT DETERMINED

TABLE 2

TOTAL Quantity (Wt. %) of Material Extracted
From Charcoal Samples

	SAMPLE NUMBER	DATE REMOVED	SOLVENTS CS2(1)	CS2(2)	CS2/12%Ace.	CS2 Ultrasonic	CH3OH	C6H12	CH2CL2
A-	A152/0599	6/3/85	24.2	25.6	26.2	28.2	17.0	22.8	25.3
B-	A151/0420	4/3/86	46.0	44.6	43.6(3)	45.7	45.2	42.9(3)	42.6(3
C-	A152/0237	8/22/84	30.9	31.1	30.8	37.7	22.2	28.1	30.9
D-	A151/0320X	3/2/86	36.3	36.6	38.5	39.3	36.6	34.6	36.5
E-	A152/0282	3/24/86	32.8	35.2	34.6	35.4	32.2	35.2	33.6
F-	GASOLINE(BASE)	NA	ND	22.4	22.5	25.8	21.9	21.0	22.2
G-	GASOLINE(BLEND)	NA	ND	20.8	20.9	22.6	21.0	21.6	19.9
	UNUSED CANISTER #1	NA	ND	ND	ND	ND	16.0	ND	ND
	UNUSED CANISTER #2	NA	ND	14.7	14.5	ND	14.0	13.1	8.5

1 - TOTAL WEIGHT % EXTRACTED DETERMINED IN PREVIOUS CANISTER STUDIES

2 - TOTAL WEIGHT % EXTRACTED DETERMINED DURING PRESENT CANISTER STUDY

3 - SAMPLE NOT ANALYZED IN DUPLICATE

NA - NOT APPLICABLE

ND - NOT DETERMINED

TABLE 3

TOTAL WEITHT % HC on Carbon as Determined
by GC/FID Detailed HC Analysis of Extracts

	SAMPLE NUMBER	DATE REMOVED	SOLVENTS CS2(1)	CS2(2)	CS2/12%Ace.	CS2 Ultrasonic	CH3OH
A-	A152/0599	6/3/85	14.4	15.4	17.9	17.2	11.9
B-	A151/0420	4/3/86	27.4	33.2	28.3	26.5	27.8
C-	A152/0237	8/22/84	17.3	21.5	21.3	19.0	17.2
D-	A151/0320X	3/2/86	8.9	15.0	14.0	18.4	12.9
E-	A152/0282	3/24/86	17.9	22.9	23.3	23.6	23.0
F-	GASOLINE(BASE)	NA	ND	15.0	14.5	14.9	7.9
G-	GASOLINE(BLEND)	NA	ND	11.9	12.0	12.7	6.5
	UNUSED CANISTER #1	NA	ND	<1.0	ND	ND	ND
	UNUSED CANISTER #2	NA	ND	<1.0	ND	ND	ND

1 - TOTAL WEIGHT % EXTRACTED DETERMINED IN PREVIOUS CANISTER STUDIES

2 - TOTAL WEIGHT % EXTRACTED DETERMINED DURING PRESENT CANISTER STUDY

3 - SAMPLE NOT ANALYZED IN DUPLICATE

NA - NOT APPLICABLE

ND - NOT DETERMINED

TABLE 3A

COMPARISON OF GC/FID HC Analysis of Sample
Extracts by HC Class (by Wt. %)

Sample Number A152/0599
Date Removed (6-3-85)

	SOLVENT					
CLASS	CS2(1)	CS2(2)	CS2/12%Ace.(3)	CS2/12%Ace.(4)	CS2(Ultrasonic)	CH3OH
Total N-PARAFFINS	0.98	0.98	1.17	0.95	1.07	0.55
Total BRANCHED PARAFFINS	5.79	6.95	7.67	6.87	7.51	4.78
Total NAPHTHANES	0.62	0.27	0.30	0.12	0.36	0.05
Total OLEFINS	0.24	0.23	0.28	0.48	0.31	0.06
Total AROMATICS	6.01	6.70	7.52	7.39	7.38	6.28
Total UNKNOWNS	0.78	0.31	0.98	0.86	0.55	0.19
Total %HC on Carbon From GC/FID	14.42	15.39	17.92	16.67	17.18	11.91
CS2 Method % Extracted	25.60	25.60	26.20	26.20	28.20	17.00
% MOIS.	0.80	0.80	0.80	0.80	0.08	0.80
% of CS2 Extract Reported by GC/FID	59.45	63.33	71.45	66.68	61.21	74.76

1- From previous canister study
2- From present canister study
3- Determined by direct injection of extract
4- Determined by vaporization of extract
NA- Not Applicable
ND- Not Determined

TABLE 3B

COMPARISON OF GC/FID HC Analysis of Sample
Extracts by HC Class (by Wt. %)

Sample Number A151/0420
Date Removed (4-3-86)

	SOLVENT					
CLASS	CS2(1)	CS2(2)	CS2/12%Ace.(3)	CS2/12%Ace.(4)	CS2(Ultrasonic)	CH3OH
Total N-PARAFFINS	0.78	0.89	0.75	1.02	0.78	0.66
Total BRANCHED PARAFFINS	2.42	2.52	2.40	3.26	2.11	2.05
Total NAPHTHANES	0.11	0.13	0.21	0.09	0.41	0.18
Total OLEFINS	0.48	0.04	0.05	0.17	0.04	0.00
Total AROMATICS	22.54	21.23	18.32	17.28	16.58	18.46
Total UNKNOWNS	1.11	8.31	6.90	5.33	6.56	6.48
Total %HC on Carbon From GC/FID	27.37	33.13	28.34	27.15	26.49	27.82
CS2 Method % Extracted	46.05	44.59	43.58	43.58	45.50	45.20
% MOis.	4.80	4.80	4.80	4.80	4.80	4.80
% of CS2 Extract Reported by GC/FID	69.43	85.21	76.05	73.31	68.76	72.20

1- From previous canister study
2- From present canister study
3- Determined by direct injection of extract
4- Determined by vaporization of extract
NA- Not Applicable
ND- Not Determined

TABLE 3C

COMPARISON OF GC/FID HC Analysis of Sample
Extracts by HC Class (by Wt. %)

Sample Number A152/0237
Date Removed (8-22-84)

	SOLVENT					
CLASS	CS2(1)	CS2(2)	CS2/12%Ace.(3)	CS2/12%Ace.(4)	CS2(Ultrasonic)	CH3OH
Total N-PARAFFINS	0.76	0.96	0.91	0.60	0.80	0.64
Total BRANCHED PARAFFINS	4.16	5.94	5.62	3.93	5.08	4.61
Total NAPHTHANES	0.23	0.23	0.22	0.11	0.22	0.16
Total OLEFINS	0.26	0.17	0.16	0.24	0.13	0.09
Total AROMATICS	10.42	12.55	11.99	10.10	10.94	10.15
Total UNKNOWNS	1.48	1.70	2.35	1.50	1.81	1.51
Total %HC on Carbon From GC/FID	16.26	21.54	21.31	16.52	18.96	17.16
CS2 Method % Extracted	31.07	31.10	30.73	30.73	38.20	21.50
% MOIS.	1.80	1.80	1.80	1.80	1.80	1.80
% of CS2 Extract Reported by GC/FID	58.13	74.93	75.14	59.62	54.40	88.19

1- From previous canister study
2- From present canister study
3- Determined by direct injection of extract
4- Determined by vaporization of extract
NA- Not Applicable
ND- Not Determined

TABLE 3E

COMPARISON OF GC/FID HC Analysis of Sample
Extracts by HC Class (by Wt. %)

Sample Number A151/0282
Date Removed (3-24-86)

	SOLVENT					
CLASS	CS2(1)	CS2(2)	CS2/12%Ace.(3)	CS2/12%Ace.(4)	CS2(Ultrasoncic)	CH3OH
Total N-PARAFFINS	0.22	0.55	0.54	0.68	0.67	0.43
Total BRANCHED PARAFFINS	5.50	4.86	4.85	4.30	5.42	3.14
Total NAPHTHANES	0.26	0.12	0.11	0.09	0.19	0.10
Total OLEFINS	0.04	0.04	0.04	0.04	0.10	0.03
Total AROMATICS	11.76	16.03	16.35	17.08	15.63	17.85
Total UNKNOWNS	0.15	1.27	1.36	1.75	1.54	1.42
Total %HC on Carbon From GC/FID	17.93	22.87	23.25	23.94	23.55	22.97
CS2 Method % Extracted	32.85	35.20	34.61	34.61	35.38	32.35
% MOIS.	4.80	4.80	4.80	4.80	4.80	4.80
% of CS2 Extract Reported by GC/FID	69.19	78.61	81.05	83.04	80.13	85.85

1- From previous canister study
2- From present canister study
3- Determined by direct injection of extract
4- Determined by vaporization of extract
NA- Not Applicable
ND- Not Determined

TABLE 3F

COMPARISON OF GC/FID HC Analysis of Sample
Extracts by HC Class (by Wt. %)

Sample Number GASOLINE (BASE)
Date Removed NA

CLASS	SOLVENT CS2(1)	CS2(2)	CS2/12%Ace.(3)	CS2/12%Ace.(4)	CS2(Ultrasonic)	CH3OH
Total N-PARAFFINS	NA	0.75	0.68	ND	0.67	0.20
Total BRANCHED PARAFFINS	NA	8.23	8.15	ND	8.23	2.69
Total NAPHTHANES	NA	0.40	0.39	ND	0.45	0.08
Total OLEFINS	NA	0.47	0.47	ND	0.48	0.13
Total AROMATICS	NA	4.75	4.45	ND	4.61	4.57
Total UNKNOWNS	NA	0.41	0.35	ND	0.43	0.21
Total %HC on Carbon From GC/FID	NA	15.01	14.49	ND	14.87	7.88
CS2 Method % Extracted	NA	22.4	22.53	ND	25.70	21.85
% MOIS.	NA	4.6	4.60	ND	4.60	4.60
% of CS2 Extract Reported by GC/FID	NA	87.54	84.73	ND	75.76	57.12

1- From previous canister study
2- From present canister study
3- Determined by direct injection of extract
4- Determined by vaporization of extract
NA- Not Applicable
ND- Not Determined

TABLE 3G

COMPARISON OF GC/FID HC Analysis of Sample
Extracts by HC Class (by Wt. %)

Sample Number GASOLINE (BLEND)
Date Removed NA

	SOLVENT					
CLASS	CS2(1)	CS2(2)	CS2/12%Ace.(3)	CS2/12%Ace.(4)	CS2(Ultrasonic)	CH3OH
Total N-PARAFFINS	NA	0.45	0.46	ND	0.50	0.07
Total BRANCHED PARAFFINS	NA	6.36	6.52	ND	6.75	1.42
Total NAPHTHANES	NA	0.17	0.18	ND	0.47	0.02
Total OLEFINS	NA	0.19	0.21	ND	0.22	0.05
Total AROMATICS	NA	4.52	4.50	ND	4.50	4.95
Total UNKNOWNS	NA	0.21	0.15	ND	0.27	0.03
Total %HC on Carbon From GC/FID	NA	11.90	12.02	ND	12.71	6.54
CS2 Method % Extracted	NA	20.85	20.92	ND	22.60	21.00
% MOIS.	NA	5.6	5.60	ND	5.60	5.60
% of CS2 Extract Reported by GC/FID	NA	83.93	84.23	ND	81.02	57.81

1- From previous canister study
2- From present canister study
3- Determined by direct injection of extract
4- Determined by vaporization of extract
NA- Not Applicable
ND- Not Determined

TABLE 4(A)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER Sample A152/0599 (Extracted for 3 hrs in CS2) (1)
DATE REMOVED 6-3-85

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT.%
TOTAL N-PARAFFINS	0.24	0.23	0.32	0.11	0.05	0.02		0.97
TOTAL BRANCHED PARAFFINS	0.21	0.70	4.70	0.48	0.42	0.18		6.69
TOTAL NAPHTHANES	0.04	0.07	0.82	0.07	0.00	0.00		1.00
TOTAL OLEFINS	0.03	0.07	0.06	0.07	0.00	0.00		0.23
TOTAL AROMATICS	0.07	0.61	1.80	2.60	0.73	0.05		5.86
TOTAL UNKNOWNS			0.01		0.10	0.14		0.25
TOTAL WT%	0.59	1.68	7.70	3.33	1.20	0.25		14.35
% OF TOTAL	4.00	11.39	52.20	22.58	8.14	1.69		100.00

CLASS VS. CARBON NUMBER

SAMPLE NUMBER Sample A152/0599 (Extracted for 3 hrs in CS2) (2)
DATE REMOVED 6-3-85

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT.%
TOTAL N-PARAFFINS	0.13	0.27	0.36	0.12	0.07	0.03	0.01	0.98
TOTAL BRANCHED PARAFFINS	0.35	0.75	4.55	0.61	0.47	0.24		6.96
TOTAL NAPHTHANES	0.05	0.03	0.13	0.06				0.27
TOTAL OLEFINS	0.02	0.06	0.14	0.01				0.24
TOTAL AROMATICS	0.00	1.43	1.79	2.54	0.84			6.60
TOTAL UNKNOWNS		0.00	0.07	0.03	0.06	0.08	0.06	0.31
TOTAL WT%	0.56	2.54	7.04	3.37	1.44	0.35	0.07	15.37
% OF TOTAL	3.62	16.52	45.78	21.94	9.36	2.31	0.47	100.00

1 - Determined from previous canister study

2- Determined from present canister study

Table 4(A2)

CLASS VS CARBON NUMBER

SAMPLE NUMBER A152/0599 (Extracted for 3 hrs. in CS2/12%Acetone)
DATE REMOVED 6-3-85

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT%
TOTAL N-PARAFFINS	0.16	0.31	0.41	0.15	0.07	0.06	0.01	1.16
TOTAL BRANCHED PARAFFINS	0.36	0.82	5.01	0.68	0.51	0.29		7.66
TOTAL NAPHTHANES	0.05	0.05	0.14	0.07				0.30
TOTAL OLEFINS	0.04	0.06	0.16	0.02				0.28
TOTAL AROMATICS	0.08	1.60	1.99	2.81	0.93	0.08		7.49
TOTAL UNKNOWNS		0.51	0.10	0.03	0.07	0.09	0.10	0.91
TOTAL WT%	0.68	3.35	7.80	3.75	1.58	0.52	0.11	17.80
% OF TOTAL	3.84	18.83	43.84	21.07	8.88	2.94	0.60	100.00

Table 4(A3)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER SAMPLE A151/0599 ULTRASONICATED IN CS2 FOR 1 HR.
DATE REMOVED 6-3-85

Wt. % HC in extract by carbon number

Class	C6	C7	C8	C9	C10	C11	C12	TOTAL WT.%
TOTAL N-PARAFFINS	0.14	0.28	0.39	0.13	0.08	0.04	0.01	1.07
TOTAL BRANCHED PARAFFINS	0.37	0.79	4.79	0.68	0.58	0.31		7.51
TOTAL NAPHTHANES	0.09	0.04	0.15	0.08				0.36
TOTAL OFEFINS	0.03	0.07	0.18	0.03				0.30
TOTAL AROMATICS	0.04	1.48	1.93	2.84	1.00	0.08		7.39
TOTAL UNKNOWNS	0.01	0.01	0.10	0.05	0.11	0.16	0.11	0.55
TOTAL WT%	0.68	2.67	7.54	3.82	1.77	0.59	0.12	17.18
% OF TOTAL	3.96	15.55	43.88	22.22	10.30	3.41	0.68	100.00

Table 4(A4)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0599 (EXTRACTED FOR 3 HRS IN METHANOL)
DATE REMOVED 6-3-85

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT.%
TOTAL N-PARAFFINS	0.03	0.16	0.24	0.07	0.07	0.03		0.59
TOTAL BRACCHED PARAFFINS	0.05	0.43	3.24	0.37	0.36	0.23		4.69
TOTAL NAPHTHANES	0.01	0.01	0.02	0.01				0.05
TOTAL OFEFINS	0.00	0.00	0.06	0.00				0.06
TOTAL AROMATICS	0.05	1.09	1.53	2.59	0.93	0.06		6.25
TOTAL UNKNOWNS	0.00	0.04	0.00		0.05	0.03	0.07	0.19
TOTAL WT%	0.15	1.74	5.09	3.05	1.42	0.34	0.07	11.84
% OF TOTAL	1.25	14.67	42.94	25.72	11.97	2.87	0.58	100.00

Table 4(B)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0420 (Extracted for 3 hrs in CS2) (1)
DATE REMOVED 4-3-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.14	0.05	0.02	0.06	0.26	0.24		0.78
TOTAL BRANCHED PARAFFINS	0.51	0.27	0.47	0.04	0.50	0.79		2.59
TOTAL NAPHTHANES		0.10	0.01					0.11
TOTAL OLEFINS	0.43	0.04						0.47
TOTAL AROMATICS	0.08	0.43	2.06	7.95	9.05	2.81		22.38
TOTAL UNKNOWNS	0.09				0.06	0.92		1.07
TOTAL WT. %	1.26	0.88	2.56	8.06	9.87	4.77		27.39
% OF TOTAL	4.60	3.22	9.33	29.41	36.04	17.40		100.00

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0420 (Extracted for 3 hrs. in CS2) (2)
DATE REMOVED 4-3-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.03	0.04	0.03	0.07	0.21	0.32	0.19	0.89
TOTAL BRANCHED PARAFFINS	0.02	0.12	0.30	0.10	0.45	1.53		2.52
TOTAL NAPHTHANES	0.09	0.05		0.00				0.13
TOTAL OLEFINS	0.01	0.03	0.00					0.04
TOTAL AROMATICS	0.26	0.54	2.09	8.19	8.54	1.62		21.23
TOTAL UNKNOWNS	0.01	0.03	0.02	0.03	2.07	2.04	4.12	8.31
TOTAL WT. %	0.42	0.80	2.44	8.38	11.26	5.51	4.31	33.13
% OF TOTAL	1.28	2.42	7.37	25.30	33.99	16.62	13.01	100.00

1- Determined from previous canister study

2- Determined from present canister study

Table 4(B2)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0420 (Extracted for 3 hrs in CS2/12%Acetone)
DATE REMOVED 4-3-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.08	0.04	0.03	0.06	0.16	0.23	0.15	0.75
TOTAL BRANCHED PARAFFINS	0.18	0.19	0.39	0.10	0.35	1.19		2.40
TOTAL NAPHTHANES	0.16	0.05						0.21
TOTAL OLEFINS	0.02	0.02	0.01					0.05
TOTAL AROMATICS	0.14	0.59	1.84	6.72	6.77	1.28		17.34
TOTAL UNKNOWNS		0.91	0.03	0.02	1.67	1.53	3.33	7.49
TOTAL WT. %	0.58	1.80	2.29	6.91	8.95	4.23	3.49	28.24
% OF TOTAL	2.04	6.38	8.12	24.46	31.68	14.98	12.35	100.00

Table 4(83)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0420
DATE REMOVED 4-3-86

(Ultrasonicated in CS2 for 1 hour)

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.06	0.03	0.02	0.07	0.15	0.28	0.16	0.78
TOTAL BRANCHED PARAFFINS	0.21	0.19	0.27	0.07	0.30	1.08		2.11
TOTAL NAPHTHANES	0.35	0.05	0.01					0.41
TOTAL OLEFINS	0.02	0.03	0.18					0.22
TOTAL AROMATICS	0.02	0.51	1.76	6.43	6.59	1.27		16.58
TOTAL UNKNOWNS		0.04		0.02	1.56	1.50	3.44	6.56
TOTAL WT.%	0.67	0.84	2.24	6.59	8.60	4.12	3.60	26.66
% OF TOTAL	2.50	3.16	8.40	24.71	32.27	15.46	13.51	100.00

Table 4(B4)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0420 (4-3-86) (Extracted for 3 hours in Methanol)
DATE REMOVED 4-3-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.05			0.05	0.16	0.28	0.14	0.67
TOTAL BRANCHED PARAFFINS	0.05	0.23	0.20	0.05	0.24	1.27		2.05
TOTAL NAPHTHANES	0.08	0.09						0.18
TOTAL OLEFINS	0.00							0.00
TOTAL AROMATICS	0.13	0.43	1.72	7.28	7.64	1.25		18.46
TOTAL UNKNOWNS	0.08	0.23			1.67	1.60	2.89	6.48
TOTAL WT. %	0.40	0.99	1.92	7.38	9.70	4.41	3.02	27.82
% OF TOTAL	1.44	3.55	6.92	26.52	34.87	15.83	10.87	100.00

Table 4C

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0237 (Extracted for 3 hrs with CS2) (1)
DATE REMOVED 8-22-84

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.12	0.06	0.13	0.15	0.12	0.06		0.64
TOTAL BRANCHED PARAFFINS	0.29	0.35	1.93	0.53	0.57	0.43		4.10
TOTAL NAPHTHANES	0.06	0.04	0.09	0.05				0.24
TOTAL OLEFINS	0.08	0.03	0.03	0.07				0.21
TOTAL AROMATICS	0.18	1.79	1.71	4.30	2.14	0.40		10.52
TOTAL UNKNOWNS					0.23	0.20		0.43
TOTAL WT. %	0.73	2.27	3.89	5.10	2.83	0.89		15.71
% OF TOTAL	4.65	14.45	24.76	32.46	18.01	5.67		100.00

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0237 (Extracted for 3 hrs with CS2) (2)
DATE REMOVED 8-22-84

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.24	0.06	0.17	0.19	0.16	0.09	0.04	0.95
TOTAL BRANCHED PARAFFINS	0.66	0.44	2.65	0.66	0.79	0.43		5.19
TOTAL NAPHTHANES	0.13	0.03	0.03	0.04				0.23
TOTAL OLEFINS	0.10	0.02	0.04	0.01				0.17
TOTAL AROMATICS	0.20	1.74	1.92	5.20	3.06	1.17		13.29
TOTAL UNKNOWNS	0.01		0.02	0.05	0.51	0.55	0.57	1.70
TOTAL WT. %	1.34	2.29	4.83	6.15	4.52	1.81	0.61	21.54
% OF TOTAL	6.21	10.61	22.42	28.55	21.00	8.40	2.82	100.00

1- Determined from previous canister study

Table 4(C2)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A152/0237 (Extracted for 3 hrs in CS2/12%Acetone)
DATE REMOVED 8-22-84

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.23	0.06	0.17	0.17	0.14	0.09	0.04	0.91
TOTAL BRANCHED PARAFFINS	0.61	0.44	2.54	0.63	0.66	0.62		5.49
TOTAL NAPHTHANES	0.13	0.03	0.02	0.04				0.22
TOTAL OLEFINS	0.09	0.01	0.05	0.01				0.16
TOTAL AROMATICS	0.37	1.73	1.84	4.84	2.84	0.39		12.02
TOTAL UNKNOWNS	0.01	0.84	0.02	0.04	0.45	0.46	0.55	2.37
TOTAL WT. %	1.44	3.11	4.64	5.73	4.09	1.56	0.59	21.17
% OF TOTAL	6.82	14.71	21.91	27.07	19.33	7.37	2.79	100.00

Table 4C3

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A152/0237
DATE REMOVED 8-22-84

Ultrasonicated in CS2 for 1 hr.

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.18	0.07	0.15	0.16	0.14	0.08	0.03	0.80
TOTAL BRANCHED PARAFFINS	0.33	0.61	2.35	0.58	0.62	0.58		5.08
TOTAL NAPHTHANES	0.10	0.07	0.02	0.04				0.22
TOTAL OLEFINS	0.07	0.02	0.03	0.01		0.34		0.48
TOTAL AROMATICS	0.16	1.56	1.72	3.61	2.64			9.69
TOTAL UNKNOWNS	0.00	0.43	0.01	0.04	0.43	0.43	0.44	1.78
TOTAL WT. %	0.83	2.75	4.27	4.44	3.83	1.44	0.47	18.04
% OF TOTAL	4.62	15.27	23.68	24.61	21.23	7.98	2.61	100.00

Table 4(C4)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A152/0237 (Extracted for 3 hrs in Methanol)
DATE REMOVED 8-22-84

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.08	0.07	0.14	0.12	0.13	0.07	0.01	0.62
TOTAL BRANCHED PARAFFINS	0.00	0.41	2.55	0.46	0.55	0.60		4.57
TOTAL NAPHTHANES	0.12	0.03		0.02				0.17
TOTAL OLEFINS	0.06	0.01	0.01					0.08
TOTAL AROMATICS		1.40	1.55	4.41	2.60	0.24		10.20
TOTAL UNKNOWNS	0.24	0.34		0.03	0.31	0.37	0.21	1.50
TOTAL WT. %	0.51	2.26	4.24	5.03	3.59	1.29	0.22	17.13
% OF TOTAL	2.95	13.20	24.73	29.38	20.95	7.51	1.28	100.00

Table 4D

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0320X (Extracted for 3 hrs in CS2) (1)
DATE REMOVED 3-2-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	TOTAL WT. %
TOTAL N-PARAFFINS	0.00		0.03	0.07			0.10
TOTAL BRANCHED PARAFFINS	0.01	0.04	0.16	0.07	0.59	0.31	1.18
TOTAL NAPHTHANES	0.00		0.03				0.03
TOTAL OLEFINS	0.00	0.01	0.01				0.03
TOTAL AROMATICS		0.22	1.77	4.57	0.83	0.12	7.51
TOTAL UNKNOWNS	0.01			0.00	0.00		0.01
TOTAL WT. %	0.03	0.27	2.00	4.71	1.42	0.43	8.86
% OF TOTAL	0.35	3.07	22.52	53.16	16.05	4.86	100.00

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0320x (Extracted for 3 hrs in CS2) (2)
DATE REMOVED 3-2-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.01	0.03	0.04	0.09	0.17	0.10	0.03	0.46
TOTAL BRANCHED PARAFFINS	0.02	0.07	0.27	0.22	0.68	0.76		2.01
TOTAL NAPHTHANES	0.01	0.02	0.00	0.03				0.06
TOTAL OLEFINS		0.02	0.02	0.00				0.04
TOTAL AROMATICS	0.01	0.46	1.96	5.63	2.40	0.28		10.74
TOTAL UNKNOWNS		0.01	0.01	0.04	0.49	0.51	0.60	1.65
TOTAL WT. %	0.05	0.59	2.30	6.01	3.74	1.64	0.63	14.96
% OF TOTAL	0.36	3.96	15.38	40.16	24.97	10.97	4.19	100.00

1- Determined from previous canister study

2- Determined from present canister study

Table 4D2

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0320x (Extracted for 3 hrs in CS2/12%Acetone)
DATE REMOVED 3-2-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.01	0.02	0.04	0.08	0.15	0.09	0.02	0.43
TOTAL BRANCHED PARAFFINS	0.02	0.08	0.36	0.22	0.63	0.72		2.03
TOTAL NAPHTHANES	0.01	0.01	0.00	0.03				0.05
TOTAL OLEFINS		0.02	0.02	0.01				0.04
TOTAL AROMATICS	0.05	0.45	1.83	5.15	2.20	0.25		9.92
TOTAL UNKNOWNS	0.01	0.03	0.01	0.05	0.44	0.41	0.46	1.41
TOTAL WT. %	0.09	0.61	2.27	5.54	3.42	1.47	0.48	13.88
% OF TOTAL	0.67	4.39	16.35	39.90	24.61	10.61	3.46	100.00

Table 4(D3)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0320X
DATE REMOVED 3-2-86

Ultrasonicated in CS2 for 1 hr.

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.02	0.03	0.05	0.11	0.21	0.12	0.04	0.58
TOTAL BRANCHED PARAFFINS	0.03	0.09	0.33	0.27	0.87	0.96		2.56
TOTAL NAPHTHANES	0.07	0.03	0.01	0.05				0.17
TOTAL OLEFINS	0.00	0.02	0.03	0.01				0.07
TOTAL AROMATICS	0.05	0.52	2.29	6.60	2.94	0.34		12.75
TOTAL UNKNOWNS	0.00	0.02	0.03	0.07	0.68	0.68	0.83	2.31
TOTAL WT. %	0.19	0.72	2.74	7.12	4.70	2.10	0.87	18.43
% OF TOTAL	1.02	3.89	14.84	38.63	25.51	11.41	4.71	100.00

Table 4(D4)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0320x (Extracted for 3 hrs in Methanol)
DATE REMOVED 3-2-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS		0.01	0.03	0.06	0.15	0.09	0.02	0.37
TOTAL BRANCHED PARAFFINS	0.01	0.09	0.13	0.15	0.48	0.66		1.52
TOTAL NAPHTHANES		0.01		0.01				0.02
TOTAL OLEFINS			0.00	0.00				0.01
TOTAL AROMATICS	0.02	0.29	1.58	5.12	2.39	0.24		9.64
TOTAL UNKNOWNS		0.03	0.00	0.03	0.39	0.39	0.46	1.30
TOTAL WT. %	0.02	0.44	1.75	5.37	3.41	1.38	0.49	12.86
% OF TOTAL	0.19	3.40	13.62	41.76	26.49	10.75	3.79	100.00

Table 4E

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0282
DATE REMOVED 3-24-86

(Extracted 3 hrs in CS2) (1)

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	TOTAL WT. %
TOTAL N-PARAFFINS	0.06	0.01	0.03		0.03		0.14
TOTAL BRANCHED PARAFFINS	0.25	0.72	3.28	0.10	0.77	0.38	5.50
TOTAL NAPHTHANES	0.04	0.02	0.05	0.16			0.27
TOTAL OLEFINS	0.01			0.01			0.02
TOTAL AROMATICS	0.04	3.09	2.62	4.94	1.06	0.02	11.77
TOTAL UNKNOWNS	0.01		0.00	0.00	0.05	0.08	0.14
TOTAL WT. %	0.41	3.84	5.99	5.20	1.92	0.47	17.83
% OF TOTAL	2.33	21.52	33.57	29.16	10.75	2.66	100.00

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0282
DATE REMOVED 3-24-86

(Extracted 3 hrs in CS2) (2)

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT.
TOTAL N-PARAFFINS	0.09	0.02	0.04	0.14	0.15	0.08	0.03	0.55
TOTAL BRANCHED PARAFFINS	0.31	0.66	2.14	0.32	0.75	0.69		4.86
TOTAL NAPHTHANES	0.06	0.02	0.00	0.04				0.12
TOTAL OLEFINS	0.01	0.02	0.02	0.00				0.04
TOTAL AROMATICS	0.01	4.26	3.05	6.10	2.35	0.27		16.04
TOTAL UNKNOWNS		0.00	0.00	0.05	0.39	0.41	0.42	1.27
TOTAL WT. %	0.48	4.98	5.25	6.64	3.65	1.44	0.44	22.89
% OF TOTAL	2.09	21.77	22.93	29.01	15.95	6.31	1.94	100.00

1- Determined from previous canister study

2- Determined from present canister study

Table 4(E2)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0282 (Extracted for 3 hrs in CS2/12%Acetone)
DATE REMOVED 3-24-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.09	0.02	0.04	0.13	0.16	0.08	0.03	0.54
TOTAL BRANCHED PARAFFINS	0.27	0.65	2.12	0.32	0.78	0.72		4.86
TOTAL NAPHTHANES	0.06	0.03	0.02	0.03				0.13
TOTAL OLEFINS	0.01	0.02	3.09					3.11
TOTAL AROMATICS	0.06	4.21		6.29	2.42	0.27		13.27
TOTAL UNKNOWNS		0.01	0.01	0.04	0.39	0.42	0.50	1.36
TOTAL WT. %	0.49	4.93	5.28	6.82	3.74	1.49	0.52	23.28
% OF TOTAL	2.10	21.18	22.67	29.30	16.09	6.42	2.25	100.00

Table 4(E3)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0282 (ULTRASONICATED IN CS2 FOR 1 HR.)
DATE REMOVED 3-24-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.13	0.04	0.06	0.13	0.18	0.11	0.03	0.67
TOTAL BRANCHED PARAFFINS	0.49	0.79	2.29	0.31	0.81	0.69		5.37
TOTAL NAPHTHHANES	0.10	0.04	0.01	0.05				0.19
TOTAL OLEFINS	0.03	0.02	0.04	0.01				0.10
TOTAL AROMATICS	0.04	4.19	2.92	5.93	2.30	0.26		15.63
TOTAL UNKNOWNS	0.01	0.01	0.01	0.08	0.43	0.47	0.53	1.54
TOTAL WT. %	0.80	5.09	5.34	6.50	3.71	1.52	0.56	23.51
% OF TOTAL	3.39	21.63	22.72	27.64	15.77	6.47	2.39	100.00

Table 4(E4)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER A151/0282 (Extracted 3 hrs in Methanol)
DATE REMOVED 3-24-86

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.01	0.00	0.03	0.10	0.17	0.09	0.03	0.43
TOTAL BRANCHED PARAFFINS	0.02	0.17	1.29	0.19	0.68	0.79		3.14
TOTAL NAPHTHANES	0.00	0.04	0.03	0.02				0.10
TOTAL OLEFINS		0.03						0.03
TOTAL AROMATICS	0.07	3.84	3.12	7.40	3.08	0.33		17.85
TOTAL UNKNOWNS	0.00	0.00		0.03	0.45	0.49	0.45	1.42
TOTAL WT. %	0.10	4.09	4.47	7.73	4.38	1.70	0.48	22.97
% OF TOTAL	0.46	17.81	19.48	33.66	19.08	7.41	2.11	100.00

Table 4(F)

CLASS VS CARBON NUMBER

SAMPLE NUMBER GASOLINE (BASE FUEL) (Extracted for 3 hours in CS2)
DATE REMOVED NA

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.44	0.17	0.05	0.03		0.05		0.74
TOTAL BRANCHED PARAFFINS	2.26	1.61	4.14	0.07	0.14	0.04		8.26
TOTAL NAPHTHANES	0.22	0.16	0.03					0.41
TOTAL OLEFINS	0.33	0.12	0.02					0.47
TOTAL AROMATICS	0.42	3.10	0.87	0.28	0.07	0.00		4.75
TOTAL UNKNOWNS	0.17	0.09	0.09	0.05				0.40
TOTAL WT. %	3.86	5.25	5.20	0.43	0.21	0.09	0.00	15.04
% OF TOTAL	25.65	34.91	34.59	2.84	1.39	0.63	0.00	100.00

Table 4(F2)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER GASOLINE (BASE) (Extracted for 3 hours in CS2/12% Acetone)
DATE REMOVED NA

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.47	0.16	0.04	0.01				0.68
TOTAL BRANCHED PARAFFINS	2.44	1.62	4.07	0.07	0.01	0.01		8.21
TOTAL NAPHTHANES	0.22	0.14	0.02					0.38
TOTAL OLEFINS	0.34	0.11	0.01					0.47
TOTAL AROMATICS	0.44	2.92	0.76	0.32	0.04	0.00		4.49
TOTAL UNKNOWNS	0.18	0.77	0.09					1.04
TOTAL WT. %	4.10	5.73	4.99	0.39	0.05	0.02	0.00	15.28
% OF TOTAL	26.84	37.50	32.66	2.58	0.33	0.10	0.00	100.00

Table 4(F3)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER GASOLINE (BASE FUEL) (Ultrasonicated in CS2 for 1 hour)
DATE REMOVED NA

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.45	0.16	0.04	0.01	0.00	0.00		0.67
TOTAL BRANCHED PARAFFINS	2.40	1.64	4.11	0.08	0.01	0.01		8.23
TOTAL NAPHTHANES	0.25	0.15	0.04					0.45
TOTAL OLEFINS	0.34	0.12	0.02					0.47
TOTAL AROMATICS	0.39	2.99	0.80	0.36	0.07	0.00		4.61
TOTAL UNKNOWNS	0.17	0.15	0.10				0.00	0.43
TOTAL WT. %	4.00	5.20	5.12	0.44	0.08	0.01	0.00	14.86
% OF TOTAL	26.93	34.98	34.44	2.97	0.56	0.09	0.03	100.00

Table 4(F4)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER Gasoline (BASE FUEL) (Extracted for 3 hours in Methanol)
DATE REMOVED NA

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT %
TOTAL N-PARAFFINS	0.02	0.09	0.03	0.01	0.02			0.17
TOTAL BRANCHED PARAFFINS	0.15	0.42	2.08	0.03	0.01	0.01		2.70
TOTAL NAPHTHANES	0.02	0.05		0.01				0.08
TOTAL OLEFINS	0.06	0.03		0.01				0.10
TOTAL AROMATICS	0.29	2.51	1.10	0.61	0.09	0.00		4.61
TOTAL UNKNOWNS	0.01	0.07	0.01	0.01	0.02	0.07	0.02	0.22
TOTAL WT %	0.56	3.17	3.22	0.67	0.15	0.08	0.02	7.87
% OF TOTAL	7.12	40.29	40.90	8.53	1.85	1.02	0.29	100.00

Table 4(G)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER GASOLINE (BLEND)
DATE REMOVED NA

(Extracted for 3 hours in CS2)

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.23	0.15	0.05	0.01				0.45
TOTAL BRANCHED PARAFFINS	0.70	1.19	4.23	0.23	0.02	0.01		6.37
TOTAL NAPHTHANES	0.04	0.10	0.03					0.17
TOTAL OLEFINS	0.09	0.09	0.01					0.19
TOTAL AROMATICS	0.13	2.97	0.99	0.39	0.03	0.00		4.52
TOTAL UNKNOWNS	0.02	0.07	0.11	0.00	0.00	0.01		0.22
TOTAL WT. %	1.22	4.56	5.43	0.64	0.05	0.02	0.00	11.92
% OF TOTAL	10.27	38.22	45.51	5.39	0.46	0.15	0.00	100.00

Table 4(G2)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER GASOLINE (BLEND) (Extracted for 3 hours in CS2/12%Acetone)
DATE REMOVED NA

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.26	0.15	0.05	0.01				0.47
TOTAL BRANCHED PARAFFINS	0.78	1.23	4.41	0.10	0.02	0.00		6.53
TOTAL NAPHTHANES	0.05	0.10	0.03					0.18
TOTAL OLEFINS	0.10	0.09	0.02					0.20
TOTAL AROMATICS	0.14	2.91	1.03	0.38	0.05	0.00		4.51
TOTAL UNKNOWNS	0.03	0.11	0.02					0.16
TOTAL WT. %	1.35	4.59	5.55	0.49	0.07	0.01	0.00	12.05
% OF TOTAL	11.17	38.13	46.05	4.04	0.55	0.06	0.00	100.00

Table 4(G3)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER GASOLINE (BLEND) (Ultrasonicated in CS2 for 1 hour)
DATE REMOVED NA

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT. %
TOTAL N-PARAFFINS	0.26	0.17	0.05	0.01	0.00			0.50
TOTAL BRANCHED PARAFFINS	0.81	1.31	4.43	0.20	0.02	0.01		6.78
TOTAL NAPHTHANES	0.30	0.12	0.05					0.47
TOTAL OLEFINS	0.10	0.09	0.02					0.21
TOTAL AROMATICS	0.16	2.86	0.94	0.43	0.09	0.01		4.49
TOTAL UNKNOWNS	0.04	0.20	0.02	0.00				0.26
TOTAL WT. %	1.67	4.75	5.52	0.65	0.11	0.02	0.00	12.72
% OF TOTAL	13.17	37.35	43.36	5.10	0.88	0.14	0.00	100.00

Table 4(G4)

CLASS VS. CARBON NUMBER

SAMPLE NUMBER GASOLINE (BLEND) (Extracted for 3 hours in Methanol)
DATE REMOVED NA

Wt. % HC in extract by carbon number

CLASS	C6	C7	C8	C9	C10	C11	C12	TOTAL WT.%
TOTAL N-PARAFFINS	0.00	0.03	0.03	0.01				0.07
TOTAL BRANCHED PARAFFINS		0.13	1.23	0.04	0.01	0.00		1.42
TOTAL NAPHTHANES	0.00	0.01	1.39					1.40
TOTAL OLEFINS		0.05						0.05
TOTAL AROMATICS	0.10	2.52		0.83	0.12	0.00		3.57
TOTAL UNKNOWNS		0.03						0.03
TOTAL WT %	0.10	2.78	2.65	0.88	0.14	0.01	0.00	6.55
% OF TOTAL	1.58	42.34	40.37	13.48	2.10	0.13	0.00	100.00

TABLE 5

% OF EXTRACT ACCOUNTED FOR BY GC/FID
Detailed HC Analysis

	SAMPLE NUMBER	DATE REMOVED	SOLVENTS CS2(1)	CS2(2)	CS2/12%Acetone	CS2 Ultrasonic	CH3OH
A-	A152/0599	6/3/85	59.5	63.3	71.5	61.2	74.8
B-	A151/0420	4/3/86	70.0	85.2	76.1	68.8	72.2
C-	A152/0237	8/22/84	61.5	74.9	75.2	53.9	87.9
D-	A151/0320X	3/2/86	72.3	88.4	81.1	91.3	82.6
E-	A152/0282	3/24/86	69.2	78.6	81.1	80.1	85.9
F-	GASOLINE(BASE)	NA	ND	87.5	84.7	75.8	57.1
G-	GASOLINE(BLEND)	NA	ND	83.9	84.2	81.0	57.8

1 - TOTAL WEIGHT % EXTRACTED DETERMINED IN PREVIOUS CANISTER STUDIES

2 - TOTAL WEIGHT % EXTRACTED DETERMINED DURING PRESENT CANISTER STUDY

3 - SAMPLE NOT ANALYZED IN DUPLICATE

NA - NOT APPLICABLE

ND - NOT DETERMINED